PATENT NO EP (UK) 0704957

TRANSLATION OF EUROPEAN PATENT (UK)
UNDER SECTION 77 (6) (a)

Current source for power supply of a consumer circuit

The invention concerns a current source for the power supply of a consumer circuit, as described in the preamble of claim 1.

A current source for the power supply of a consumer circuit of a direct current consumer is known from US 4.635.181 A, with which current source the consumer device is supplied from a power source via a full bridge. In order to achieve a currentless turn-off of the individual switches of the full bridge, a relieving network with two capacitors, connected to positive and negative potential, is provided for each bridge arm. The relieving network is activated via two opposite-polarity switching devices disposed parallel to one another, whereby activation takes place via secondary coils of a transformer. The primary winding of the transformer is disposed in the connecting line between the two bridge arms so that the switching devices are activated by means of the current flow through the primary winding.

Furthermore, from the article „The Analyses of ZVS Turn-off Loss and the New Snubber Circuit for the ARCP Inverter", conference report IECON '94, Bologna, pages 316 to 321, a current source for the power supply of a consumer circuit is known, with which, however, the activation of the two switching devices provided for the relieving networks takes place via a control device. Further known from this article is the use of IGBTs as switches for the individual bridge arms of the full bridge.

Known power sources for the power supply of a consumer circuit of a direct current consumer are provided with an intermediate circuit between an alternating voltage network and a consumer circuit. The intermediate circuit comprises two consumer supply lines, one of which has positive potential and the other negative potential. A full bridge having two switching devices switched in parallel is placed in the intermediate circuit between

these supply lines, whereby each of these switching devices has two switches connected in series. Between the switches, the two switching devices are connected with a connecting line into which a transmission device in the form of a transformer is interconnected. On each side of the transmission device, between the connecting line and the positive or negative potential, a free-running diode is disposed. The switches of the switching devices are connected to the control device via control lines. The disadvantage of a current source of this kind is the high power loss that occurs when the switches are turned off.

The invention in question is based on the problem of creating a current source for the power supply of a direct current consumer that has a long service life and only low power losses.

The problem of this invention is solved by means of the features in the characterising part of claim 1. The advantage of this solution is that, using low-cost isolated gate bipolar transistors in the power source design, a long service life is achieved in that, by the arrangement of the auxiliary switches and power stores assigned to them, a virtually currentless turn-off of the switches of the switching devices is achieved, thereby preventing the power loss on turn-off of a switch. By preventing this power loss, excessive thermal stressing of the switches is avoided, as a result of which the previously mentioned isolated gate bipolar transistors can be used.

Also advantageous is an embodiment according to claim 2, since this results in a cost reduction for the full bridge.

Finally, however, an embodiment according to claim 3 is also advantageous, since it enables a precise time for switching off the auxiliary switches to be defined, as a result of which no power remains stored in the transmission device.

The invention is explained in greater detail below with reference to the embodiments shown in the drawings, wherein:

Fig. 1 shows a circuit diagram of a power source with a full bridge in simplified schematic form.

Fig. 2 shows a full bridge for generating a direct voltage according to the invention in simplified schematic form.

Fig. 3 is a diagram in which the turn-off losses of a switch are shown, minus the solution of the full bridge according to the invention.

Fig. 4 is a diagram in which the turn-off losses of a switch are shown with the solution according to the invention.

Fig. 1 shows a current source 1, which is connected to an alternating voltage network 2. In our example, alternating voltage network 2 is formed by a three-phase alternating voltage network comprising three phase conductors 3. The current source 1 is connected to alternating voltage network 2 via incoming lines 4, 5, 6. The current source 1 is also equipped with a rectifier 7, which is connected to incoming lines 4, 5, 6. The rectifier 7 may be in the form of either a bridge rectifier or individual diodes.

An intermediate circuit 8 is connected to outputs 11, 12 of rectifier 7 via supply lines 9, 10. The rectifier 7 supplies supply line 9 with positive potential and supply line 10 with negative potential.

At the output of intermediate circuit 8, terminals 13, 14 are connected to supply lines 9, 10. The intermediate circuit 8 is equipped with an inductance 15, which is interconnected in supply line 9 between output 11 of rectifier 7 and terminal 13. The intermediate cir-

cuit 8 is also equipped with a switch 16, which is preferably in the form of a transistor. This switch 16 is connected to supply line 9 in parallel with rectifier 7, but between inductance 15 and terminal 13, and to supply line 10 between output 12 and terminal 14. A diode 17 is also disposed in the forward conducting direction in supply line 9 between the connection point of switch 16 and terminal 13. In parallel with switch 16 is a power store 18, which is in the form of a capacitor 19, whereby capacitor 19 is connected between diode 17 and terminal 13 and between the connecting point of switch 16 in supply line 10 and terminal 14. At the output of intermediate circuit 8, i.e. at terminals 13, 14, a full bridge 20 is also connected. Full bridge 20 is in the form of two switching devices 21, 22. Switching devices 21, 22 are in the form of two series-connected switches 23, 24 and 25, 26. The input of switching device 21 is connected to terminal 13 via a line 27. The output of switching device 21 is connected to terminal 14 via a line 28, as a result of which switching device 21 is switched in parallel with rectifier 7. The second switching device 22 is connected in parallel with switching device 21, i.e. with lines 27, 28. Between the two series-connected switches 23, 24, a connecting line 29 is connected to switching device 21. With a transmission device 30 interconnected, this connecting line 29 is in turn connected between switches 25, 26 of switching device 22.

Transmission device 30 supplies a direct current consumer 32 with positive and negative potential via star connection 31. One output 33 of transmission device 30 supplies direct current consumer 32 with positive potential via a line 34 with interconnection of a diode 35. A further output 36 of transmission device 30 is connected to line 34 between diode 35 and direct current consumer 32 via a line 37 with interconnection of a diode 38. Direct current consumer 32 is supplied with negative potential via line 39.

Current source 1 is also equipped with a control device 40. Control device 40 activates switches 16 and 23 to 26 via lines 41 to 45.

If current source 1, i.e. rectifier 7, intermediate circuit 8 and full bridge 20, is connected to alternating voltage network 2, rectifier 7 rectifies the alternating voltage of the alternating voltage network via incoming lines 4, 5, 6, i.e. rectifier 7 applies a direct voltage to supply lines 9, 10, whereby supply line 9 comprises the positive potential and supply line 10 comprises the negative potential.

Control device 40 then activates intermediate circuit 8 in such a way that switch 16 is closed, as a result of which power is stored in inductance 15. Subsequently, control device 40 opens switch 16, as a result of which the power in inductance 15 can flow via diode 17 into power store 18. Here, control of intermediate circuit 8 by control device 40 takes place by constant comparison of the actual voltage at terminal 13 with a preselectable setpoint value. The actual voltage at terminal 13 is passed on to control device 40 via a line 46. Control device 40 now activates switch 16 in such a way that the level of the voltage at the output of intermediate circuit 8, i.e. at terminals 13, 14, can be controlled by means of the duty cycle of switch 16.

This embodiment of intermediate circuit 8 in the form of a step-up converter was selected because the level of the voltage at terminals 13, 14 is independent of the voltage at alternating voltage network 2, i.e. in the event of fluctuations in the input voltage of alternating voltage network 2, it can be corrected by intermediate circuit 8 or control device 40, so that a constant voltage is always available at terminals 13, 14. It is also possible, however, to dispose other direct voltage sources, such as a rectifier with a capacitor, upstream of full bridge 20.

Irrespective of the control of switch 16, control device 40 activates switches 23 and 26 via lines 42 and 44. As a result of the activation of switches 23 and 26, the positive potential now flows from terminal 13 via switch 23, connecting line 29 of transmission device 30, and switch 26 to terminal 14, i.e. to the negative potential or power store 18, as a result of which the circuit is closed. As a result of the flow through the first section of

transmission device 30, a current is induced in the second section of transmission device 30, as a result of which direct current consumer 32 can be supplied with the positive and negative potential. After a specific, pre-selectable period of time, control device 40 opens switches 23 and 26 and activates switches 24 and 25 via lines 43 and 45, as a result of which the positive potential can flow from terminal 13 via switch 25, the first section of transmission device 30 and switch 24 to terminal 14. As is evident, the current flows from terminal 13 to terminal 14, but in different directions, i.e. the current flows firstly from switch 23 via transmission device 30 in the direction of switch 26, and subsequently from switch 25 via transmission device 30 to switch 24, as a result of which transmission device 30 is driven in different current directions alternately. As a result of this change of direction of the current flow, an alternating voltage is applied at high frequency to transmission device 30 from the direct voltage present at terminals 13, 14, as a result of which a current is induced on the secondary side of transmission device 30 and this current is in turn rectified, as a result of which direct current consumer 32 can be supplied with a positive and negative potential.

Fig. 2 shows the full bridge 20 according to the invention, which, as described in Fig. 1, is in the form of switching devices 21, 22 and transmission device 30, whereby switches 23 to 26 are formed by isolated gate bipolar transistors. The difference between a normal power-MOS transistor and an isolated gate bipolar transistor is that, when an isolated gate bipolar transistor is turned off, a current tail occurs, which can lead to destruction in the event of higher switching frequencies, as in the case of the full bridge 20 shown. This disadvantage may be largely compensated by means of the embodiment of full bridge 20 described below.

The full bridge 20 is here supplemented by free-running diodes 47 to 50, which are disposed parallel to individual switches 23 to 26.

Furthermore, a power store 51, in the form of a capacitor 52, is disposed via a power line 53 between line 27, i.e. terminal 13, and line 54, which connects switches 23 and 24 of switching device 21. Interconnected between capacitor 52 and the nodal point between power line 53 and line 54 is a further auxiliary switch 55, which again is in the form of an isolated gate bipolar transistor, and a diode 56, which are both disposed in the forward conducting direction towards power store 51. Parallel to the combination of auxiliary switch 55 and diode 56 is disposed a further combination of a diode 57 and an auxiliary switch 58, again in the form of an isolated gate bipolar transistor, whereby diode 57 and auxiliary switch 58 are disposed in the forward conducting direction from the nodal point of power line 53 to line 54. Diodes 56 and 57 may also be disposed at the inputs or outputs of auxiliary switches 55 and 58.

A further power store 59, again in the form of a capacitor 60, is disposed via power line 61 with a line 62, which connects switches 25 and 26 of switching device 22, and line 28. Simultaneously, a combination of a diode 63 and an auxiliary switch 64, again in the form of an isolated gate bipolar transistor, is interconnected between the connection point of power line 61 with line 62 and the power store 59, whereby diode 63 and auxiliary switch 64 are disposed in the forward conducting direction towards power store 59. Parallel to the combination of diode 63 and auxiliary switch 64 is disposed a further combination of a diode 65 and an auxiliary switch 66, again in the form of an isolated gate bipolar transistor, whereby diode 65 and auxiliary switch 66 are disposed in the forward conducting direction towards the nodal point of power line 61 with line 62. Diodes 63 and 65 may be connected at the inputs or outputs of auxiliary switches 64 and 66. The additionally provided auxiliary switches 55, 58, 64 and 66 are again connected to control device 40 via lines 67 to 70.

Owing to the provision of the additional components, switches 23 to 26 can be turned off in a currentless state by control device 40, as a result of which the disadvantage of the

current tail when using isolated gate bipolar transistors can be almost completely corrected.

The function of full bridge 20 now takes place to the extent that control device 40 triggers switches 23 and 26 via lines 42 and 44, as a result of which, as described in Fig. 1, the current can flow from terminal 13 via line 27, switch 23 and connecting line 29 to the first section of transmission device 30. From the first section of transmission device 30, the current flows on via connecting line 29 and switch 26 to line 28, as a result of which the circuit between the positive and negative potentials is closed. As described in Fig. 1, as a result of the flow through the first section of transmission device 30, a current is induced in the second section of transmission device 30, as a result of which direct current consumer 32 is supplied with current and voltage. Because of different numbers of windings, it is possible here for transmission device 30 to step up or attenuate the voltage at direct current consumer 32, as a result of which direct current consumer 32 has more or less current or voltage at its disposal.

Simultaneously with the activation of switches 23 and 26, control device 40 activates auxiliary switches 58 and 64 via lines 67 and 69.

Once a pre-selected period of time has elapsed, the control device 40 turns off switches 23 and 26 via lines 42 and 44. However, auxiliary switches 58 and 64 remain turned on for a specific pre-selectable period of time. However, since switches 23 and 26 are in the form of isolated gate bipolar transistors, without the previously described addition of full bridge 20, these switches 23 and 26 would not turn off the current flow promptly like a normal power-MOS transistor owing to the stored power in transmission device 30, and instead the typical current tail would occur at switch 23 and 26, leading to high power losses and to the destruction of switches 23, 26.

However, since auxiliary switches 58 and 64 are turned on, the stored power may in-

crease to the operating voltage as a result of the increase of the voltage at the nodal point of connecting line 29 and line 62 and at power store 59, as a result of which, in order to give off the stored power in transmission device 30, a circuit forms from transmission device 30 via diode 63, auxiliary switch 64, power store 59, 18, 51, diode 57 and auxiliary switch 58 to the transmission device, and the stored power is given off to power store 51 and 59, as a result of which switches 26 and 23 can turn off in a currentless state, therefore independently.

Once a pre-selectable period of time has elapsed, control device 40 switches off auxiliary switches 58 and 64 via lines 67 and 69. However, auxiliary switches 58 and 64 are currentless here, since the period of time for switching off auxiliary switches 58 and 64 is of such a length that the power stored in transmission device 30 has already flowed into capacitors 52 and 60, as a result of which no more current can flow via auxiliary switches 58 and 64.

When auxiliary switches 58 and 64 have been turned off, control device 40 turns on switches 24, 25 and auxiliary switches 55 and 66 via lines 43 and 45 and 68 and 70, as a result of which the current can flow from terminal 13 via switch 25, transmission device 30 and switch 24 to the negative potential of terminal 14, and the current flow now travels in the reverse direction through transmission device 30, so that current and voltage can again flow to the direct current consumer 32. If no polarity reversal of transmission device 30 were to take place, the inductance in transmission device 30 would become saturated after a certain period, as a result of which no current would be induced in the second section of transmission device 30, so that direct current consumer 32 could not be supplied with current and voltage. Auxiliary switches 55 and 66 are, however, currentless while switches 25 and 24 are turned on.

Once the pre-selectable period for turning switch 23 to 26 on and off has elapsed, control

device 40 switches off switch 25 and 24 by removing the control voltage from lines 45 and 43 respectively.

As a result of switches 24, 25 being turned off, the power stored in transmission device 30 commutates immediately via auxiliary switches 55 and 66 and via diodes 56, 65 to power stores 51 and 59. However, since the current flow through transmission device 30 is now in the reverse direction, a new circuit forms now from transmission device 30 via diode 56, auxiliary switch 55, power stores 51, 18, 59, diode 65 and auxiliary switch 66 to transmission device 30, as a result of which the stored power in transmission device 30 is opposed to the stored power in power stores 51 and 59, so that power stores 51 and 59 and transmission device 30 are discharged. The discharge of power stores 51 and 59 takes place because, in the previously described switching cycle, power stores 51 and 59 were charged with the power stored in transmission device 30 according to the previously described circuit. However, since the positive potential of the stored power flows from the nodal point of power line 53 with line 54 in the direction of capacitor 52, and not, as previously, from the nodal point of line 62 with power line 61 in the direction of capacitor 60, capacitors 52 and 60 are discharged through polarity reversal.

Simultaneously, capacitor 60 is supplied with negative potential, i.e. its polarity is again reversed and the power in stored capacitor 60 is returned via line 28 to supply line 10 or terminal 14. In the event of a variable load, i.e. with differing load flows, the charging and discharging of capacitors 52 and 60 may differ, i.e. sometimes capacitor 52 and 60 are fully charged or fully discharged, and sometimes partially charged and partially discharged.

By way of simplification, it can be stated that capacitors 52 and 60 are always subject to charge reversal by the stored power in transmission device 30, so that virtually no current tail occurs at switches 23 to 26, since the current is carried past them in parallel. Neither does a current tail occur at the further auxiliary switches 55, 58, 64 and 66, because,

once the stored power in transmission device 30 has decayed, the current through auxiliary switches 55, 58, 64 and 66 becomes zero.

The normally very high turn-off losses of switches 23 to 26 are hereby restricted exclusively to the conductive losses from the further particular auxiliary switches 55, 58, 64 and 66 that are turned on, and from the additionally provided diodes 56, 57, 63 and 65 and capacitors 52 and 60. These losses occur only if the further auxiliary switches 55, 58, 64 and 66 are turned on, whereby switches 23 to 26 are turned off.

Furthermore, the stored power in transmission device 30 is always stored in capacitors 52 and 60 and is therefore never lost, as in the case of circuits that are part of the prior art; instead, it oscillates backwards and forwards between transmission device 30 and power stores 51, 59.

Figs. 3 and 4 show the turn-off behaviour of one of switches 23 to 26, for example switch 26. Here, Fig. 3 shows turn-off behaviour without the addition of full bridge 20 according to the invention, and Fig. 4 shows the turning off of switch 26 with the addition of full bridge 20 according to the invention. As previously described, switch 26 is in the form of an isolated gate bipolar transistor. Current I and U is plotted on the ordinate and time t on the abscissa.

Fig. 3 shows the turn-off behaviour of switch 26 without the addition according to the invention. Here, a current characteristic 71 corresponds to the current path of the turn-off cycle of switch 26, which is measured between the nodal point of connecting line 29 with line 62 and to line 28. The voltage curve via switch 26 is also entered by means of voltage characteristic 72. As is apparent from the diagram in Fig. 3, switch 26 is turned off by control device 40 at time 73, as a result of which the current starts to decrease and the voltage rises abruptly to the operating voltage of intermediate circuit 8. Because of the power stored in transmission device 30, switch 26 remains independently conductive,

i.e. the current slowly starts to decrease and, on reaching the abscissa, is turned off. The area inside current characteristic 71 and voltage characteristic 72 would occur as a power loss at switch 26, i.e. because of the relatively high power loss, as shown hatched, switch 26 heats up very greatly, which could lead to destruction.

Fig. 4 shows the same turn-off behaviour of the same switch 26, with the addition of full bridge 20 according to the invention being used for this. This diagram again plots a current characteristic 74 of switch 26 and a voltage characteristic 75 of switch 26, which corresponds to the capacitor voltage of capacitor 60. A current characteristic 76 of auxiliary switch 64, which also corresponds to diode 63, is also plotted, from which it is apparent that the stored power of transmission device 30 flows through auxiliary switch 64 and diode 63 to capacitor 60.

At a time 73, switch 26 is again turned off by control device 40, as a result of which the current through switch 26 falls to zero. This is reached at time 77. Simultaneously, the voltage at switch 26 or capacitor 60 attempts to rise. As described in Fig. 3, the voltage attempts to rise rapidly to the operating voltage of intermediate circuit 8, as is apparent from voltage peak 78. This voltage peak arises because auxiliary switch 64 or diode 63 need a certain period to switch the power from transmission device 30 through to power store 59.

Once auxiliary switch 64 has switched through, the voltage at switch 26 or capacitor 60 falls again, and then rises slowly as far as the corresponding operating voltage, as apparent between times 79 and 80. Once the voltage at capacitor 60 or switch 26 has increased to a certain extent, switch 26 again becomes slightly conductive, i.e. part of the current flowing through auxiliary switch 64 and diode 63 to capacitor 60, as shown by current characteristic 76, now also flows through switch 26, as shown by current tail 81 on current characteristic 74 of switch 26. This current tail 81 rises to a certain value in accordance with the voltage or the current from the stored power, and then slowly de-

cays. This current tail 81 now forms the losses caused by the isolated gate bipolar transistor. The current flow of the stored power from transmission device 30 to capacitor 60 is shown on the further current characteristic 76 of auxiliary switch 64. Once the power has been completely given off by transmission device 30, the current becomes zero, as shown at time 82, and capacitor 60 is fully charged or discharged. All switches 23 to 26 and auxiliary switches 55, 58, 64 and 66 are also turned on in a currentless state.

Control device 40 can now turn off auxiliary switch 64 in a currentless state, as a result of which no further losses of a current tail will occur on turn-off of auxiliary switch 64, since no more current is stored in transmission device 30.

If the two diagrams, or the power losses of switch 26, shown hatched, are now compared, it will be noted that the solution according to the invention achieves a significant reduction of the turn-off power loss of the isolated gate bipolar transistor, as a result of which this arrangement of the additional components of the isolated gate bipolar transistor can be used in a full bridge 20 with high switching frequency, e.g. lying between 20 and 100 kHz, which is not possible in an embodiment as in Fig. 3 without additional load relief for the isolated gate bipolar transistor.

It is also possible for additional auxiliary switches 55, 58, 64 and 66 to be designed as normal transistors as they do not have to be in the form of isolated gate bipolar transistors.

It should also be pointed out that, with the power losses occurring as a result of current tail 81, additional minimal power losses occur as a result of the conductive losses of the further auxiliary switches 55, 58, 64 and 66 and diodes 56, 57, 63 and 65, which, however, in a consideration of total power losses, results in a significant reduction of power loss compared with normal turn-off of an isolated gate bipolar transistor. It is also pos-

sible, by appropriate dimensioning of capacitors 52, 60, for current tail 81 of switches 23 to 26 to be reduced.

Furthermore, it is possible for a detecting element for the current strength to be disposed in power line 53 between auxiliary switch 55, 58 and power store 51, and for the control device to apply a turn-off control signal to auxiliary switches 55, 58 or 64, 66 when current strength approaches zero.

It is further advantageous if, in each clock cycle, the time span between the turn-off of the switches and the subsequent turn-off of the auxiliary switches is in the micro-second range.

A further favourable process sequence is achieved if the capacity of the power store is such that, owing to the voltage rise formed at the nodal points of the line connected by the switches with the power line, the switches turned off immediately before each switching device become conductive to a small extent.

Above all, the individual embodiments shown in Figs. 1, 2, 3 and 4 may form the object of independent solutions according to the invention. The relevant problems and solutions according to the invention are described in the detailed descriptions accompanying these Figures.

List of Reference Numbers

1	Current source
2	Alternating voltage network
3	Phase conductor
4	Incoming line
5	Incoming line
6	Incoming line
7	Rectifier
8	Intermediate circuit
9	Supply line
10	Supply line
11	Output
12	Output
13	Terminal
14	Terminal
15	Inductance
16	Switch
17	Diode
18	Power store
19	Capacitor
20	Full bridge
21	Switching device
22	Switching device
23	Switch
24	Switch
25	Switch
26	Switch
27	Line

28	Line
29	Connecting line
30	Transmission device
31	Star connection
32	Direct current consumer
33	Output
34	Line
35	Diode
36	Output
37	Line
38	Diode
39	Line
40	Control device
41	Line
42	Line
43	Line
44	Line
45	Line
46	Line
47	Free-running diode
48	Free-running diode
49	Free-running diode
50	Free-running diode
51	Power store
52	Capacitor
53	Power line
54	Line
55	Auxiliary switch
56	Diode

57	Diode
58	Auxiliary switch
59	Power store
60	Capacitor
61	Power line
62	Line
63	Diode
64	Auxiliary switch
65	Diode
66	Auxiliary switch
67	Line
68	Line
69	Line
70	Line
71	Current characteristic
72	Voltage characteristic
73	Time
74	Current characteristic
75	Voltage characteristic
76	Current characteristic
77	Time
78	Voltage peak
79	Time
80	Time
81	Voltage tail
82	Time

Claims

1. Current source for power supply of a consumer circuit of a direct current consumer (32) with an intermediate circuit (8) arranged between an alternating voltage network (2) and a consumer circuit, which has one supply line (9, 10) with positive potential and one with negative potential, between which two parallel switched switching devices (21, 22) are arranged, which comprise two switches (23 to 26) switched in a row, and which between the switches (23 to 26) of each switching device (21, 22) are connected together by a connecting line (29), in which a transmission device (30) formed by a transformer is interconnected, and on both sides of the transmission device (30) between the connecting line (29) and the positive and negative potential a free-running diode (47 to 50) is arranged, and between the switches (23 to 26) of each switching device (21, 22) a power line (53, 61) is connected, wherein in the power lines (53, 61) several capacitors (52, 60) are arranged between the positive and negative potential, and between each capacitor (52, 60) and each switching device (21, 22) two parallel arranged opposite poled auxiliary switches (55, 58, 64, 66) are interconnected, and the switches (23 to 26) are connected with a control device (40), characterised in that the switches (23 to 26) of the switching devices (21, 22) are formed by isolated gate bipolar transistors, and in that to each switching device (21, 22) one of the capacitors (52, 60) and two of the auxiliary switches (55, 58, 64, 80) respectively are assigned, wherein a diode (56, 57, 63, 65) is connected in forward conducting direction before the auxiliary switches (55, 58, 64, 80) to their inputs and outputs and in that the power line (53) is connected to the capacitor (52) with the positive potential, and the power line (61) to the additional capacitor (60) with the negative potential.

2. Current source according to claim 1, characterised in that the auxiliary switches (55, 58, 64, 66) are in the form of power MOS transistors.

3. Current source according to claim 1 or 2, characterised in that in the power line (53) between the auxiliary switch (55, 58) and power store (51) a detecting element for current strength is arranged, and in that the control device with a current strength falling to zero at the auxiliary switches (55, 58) or (64, 66) a control signal is set to switch off.

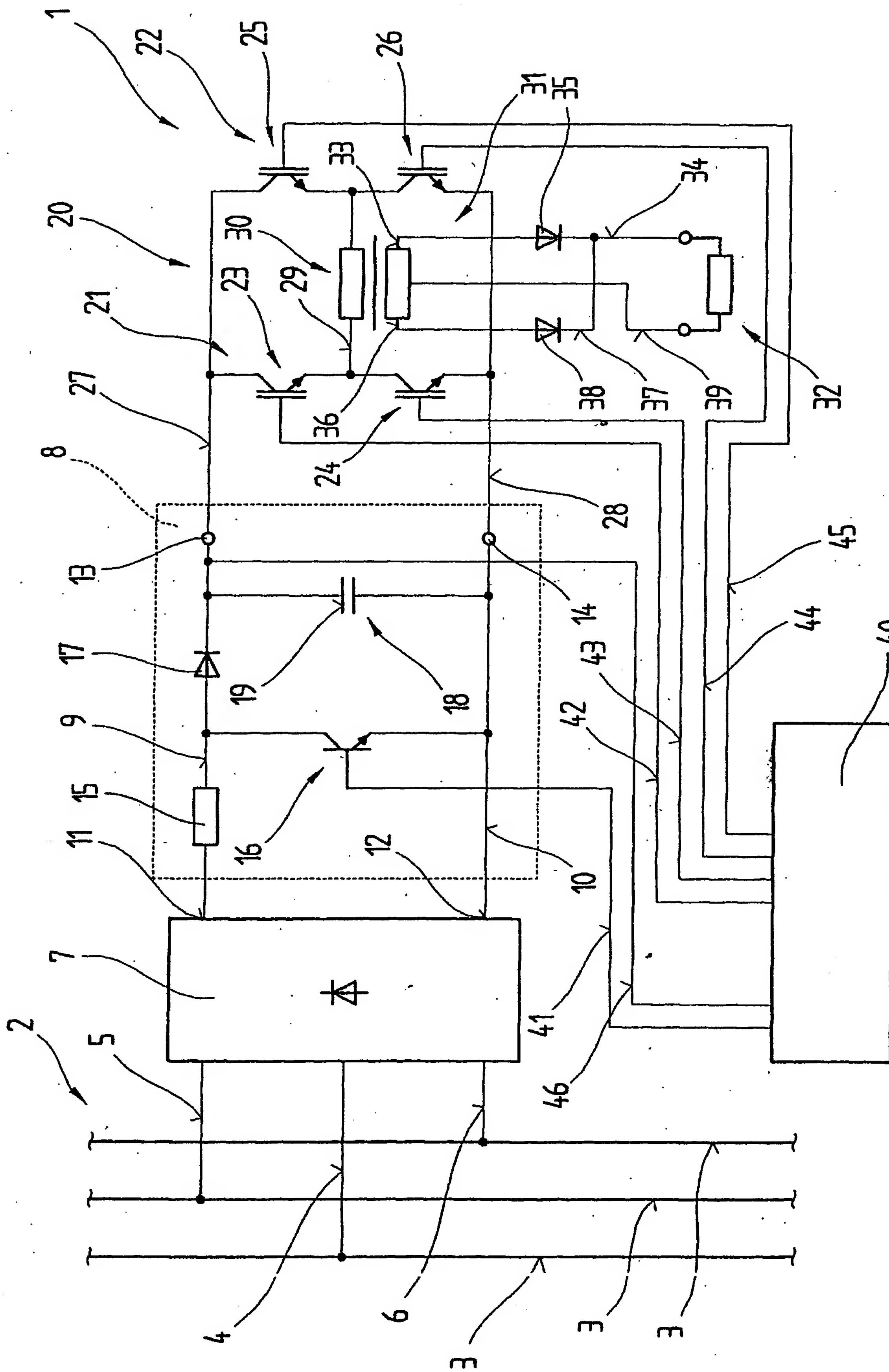
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Fig.1

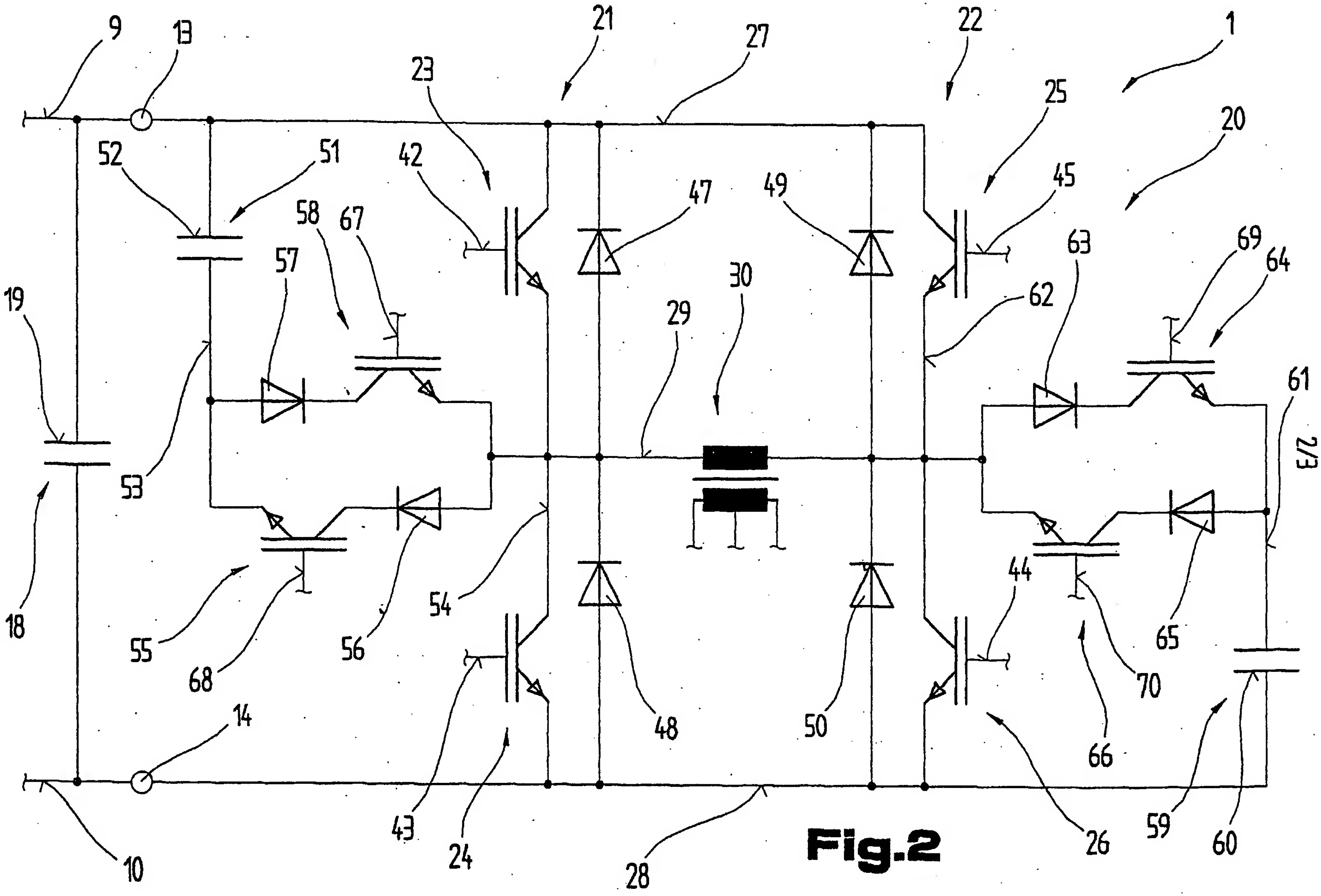
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Fig.2

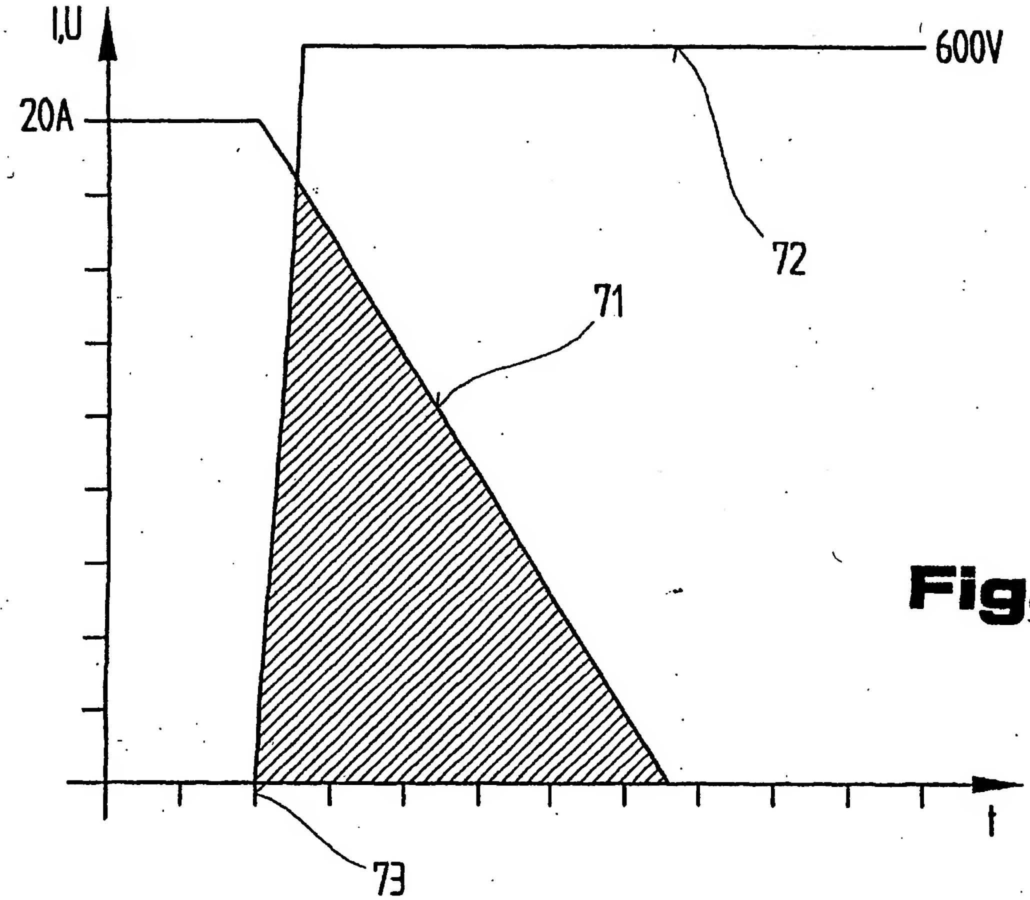

Fig.3

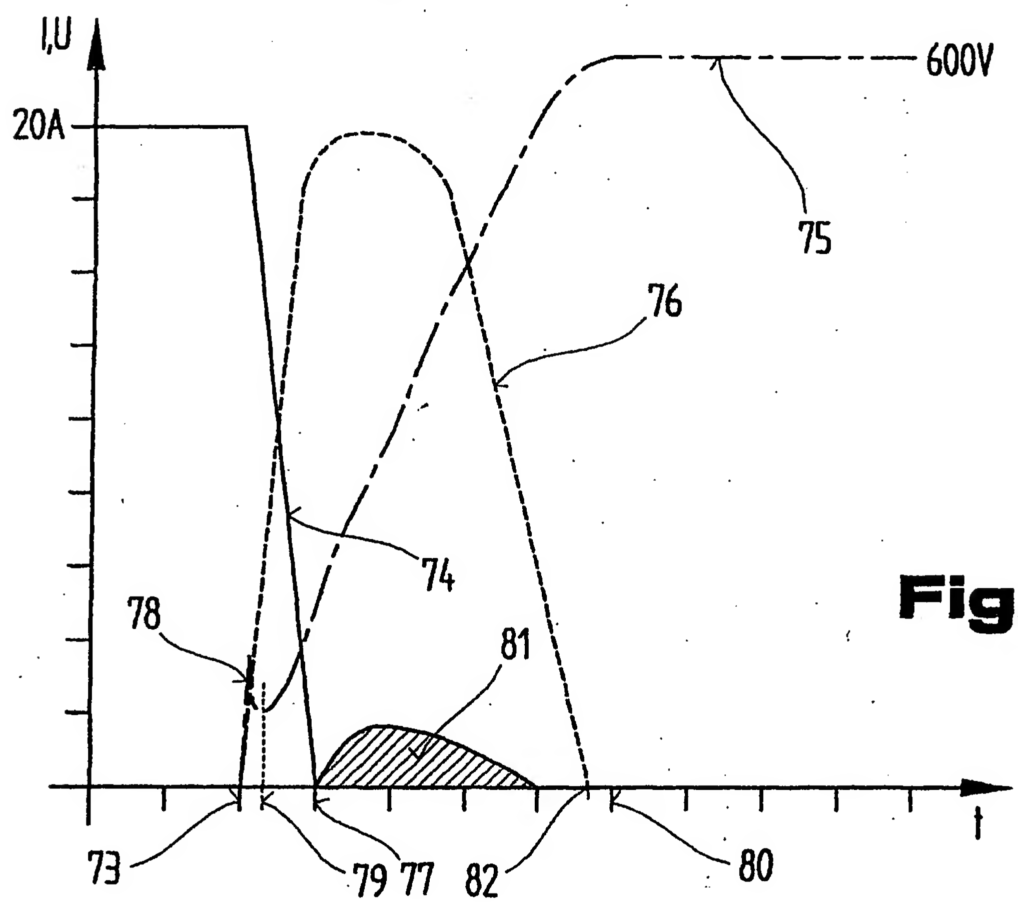

Fig.4